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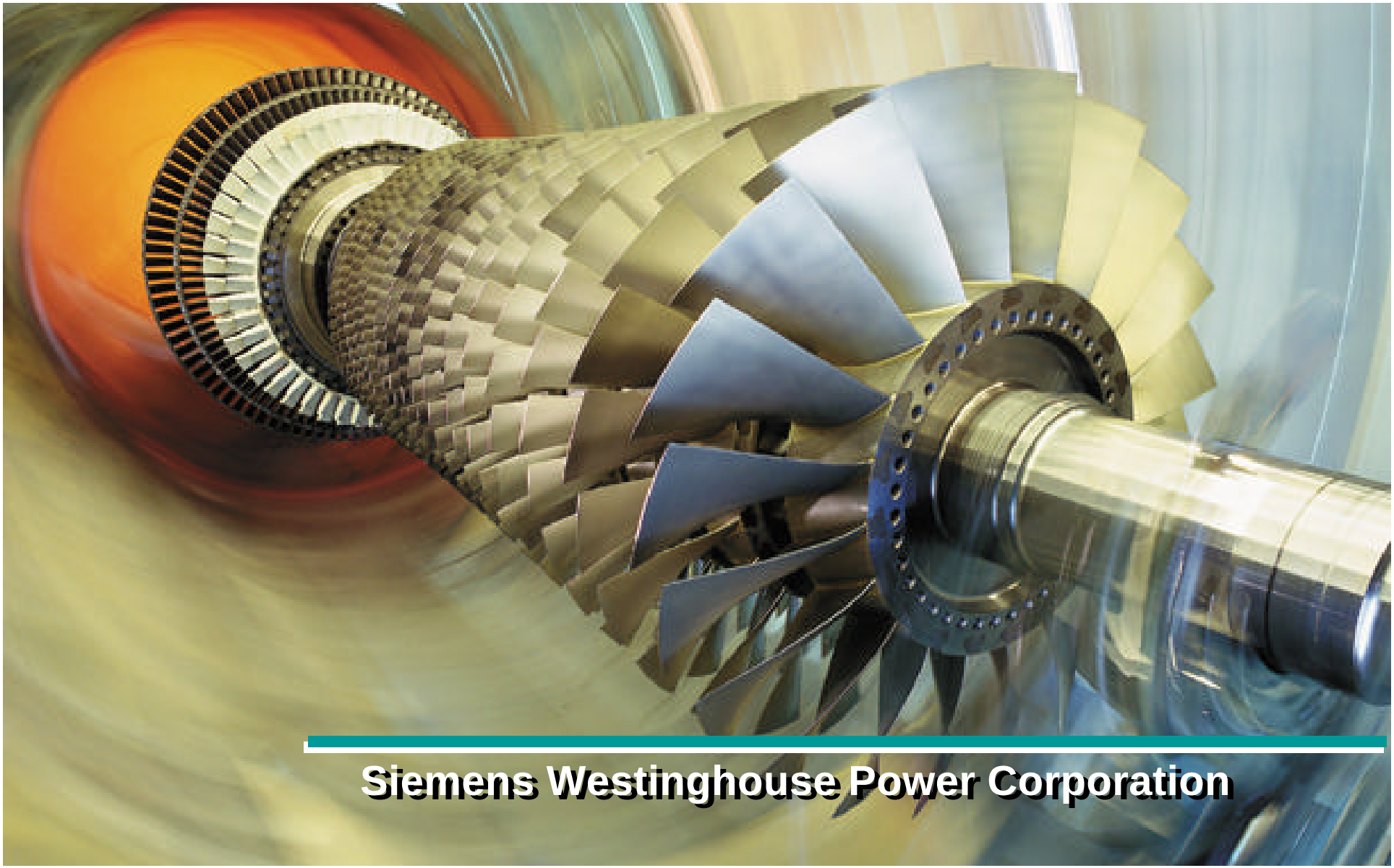

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Siemens Westinghouse Power Generation Next Generation Technology Programs

Presented At
Turbine Power Systems Conference
Galveston, Texas
February 25-26, 2002

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Next Generation Technology Programs

- Next Generation Gas Turbine Systems
  (DE-AC26-00NT40851)
- Gas Turbine Reheat Using Insitu Combustion
  (DE-FC26-00NT40913)
- On-Line Thermal Barrier Coating Monitor for Real-Time Failure Protection and Life Maximization
  (DE-FC26-01NT41232)

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NEXT GENERATION GAS TURBINE SYSTEMS
(DE-AC26-00NT40851)

Siemens Westinghouse Power Corporation
for
U.S. Department of Energy
National Energy Technology Laboratory

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Next Generation Gas Turbine Systems

DOE's NGTP Goals and Suggestions

Compared to 1999 State-of-the-art systems, the proposed system shall be greater than 30 MWs and include:

- Improved LHV net system efficiency ³15%
- ³50% improvement in turndown ratio
- ³15% reduction in COE, O&M and capital costs
- Improved service life
- Reduction of emissions (Carbon and NOx)
- *Building Block for Vision 21 System*
- Capability to use multiple fuels
- 400 starts / year with rapid start capability
- Improved RAM

DOE's suggested approach

- Solutions that embody development of several enabling technologies to enhance multiple concepts, cycle configurations, or fleet of existing core engines

DOE's suggested systems

- NGCC
- IGCC/PFBC/HIPPS
- Repowering
- Novel cycles
- Biomass / Alternate fuels
- Dual use technologies

DOE's suggested duty cycles

- Base load
- Distributed generation
- Flexible / intermediate duty
- Peaking
- Load following

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Next Generation Gas Turbine Systems

Scope of Work

- 22 Month Study
- Feasibility Study
  - System Definition
  - Market Assessment & Customer Surveys
  - Public/Vision 21Benefits
  - Development Plan
  - Technology Roadmap

Objective

- Evaluate proposed modular NGGT system
  - Technical Feasibility
  - Economic Feasibility
  - Future Markets and Benefits
  - Development

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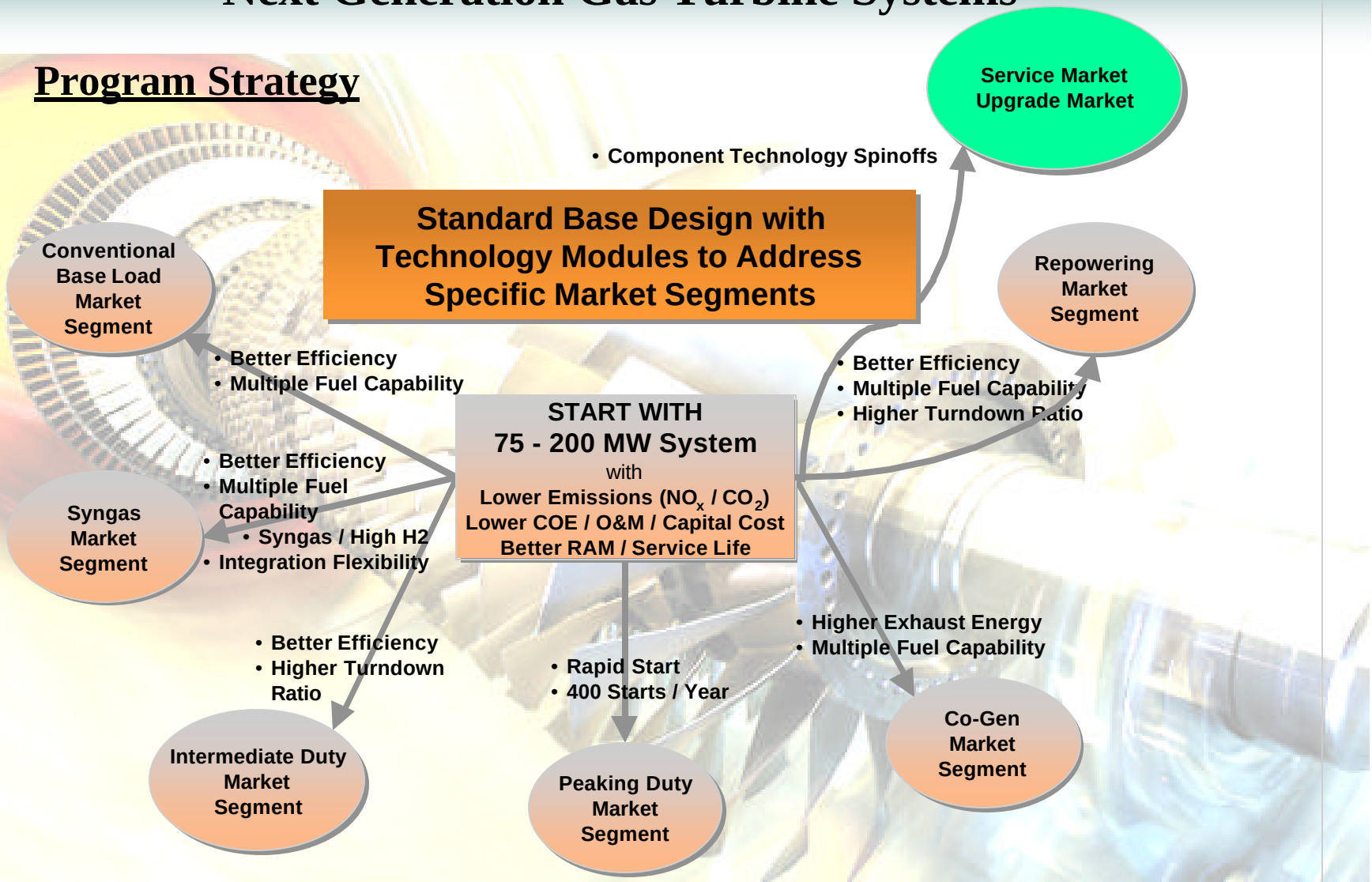
Next Generation Gas Turbine Systems

Program Strategy



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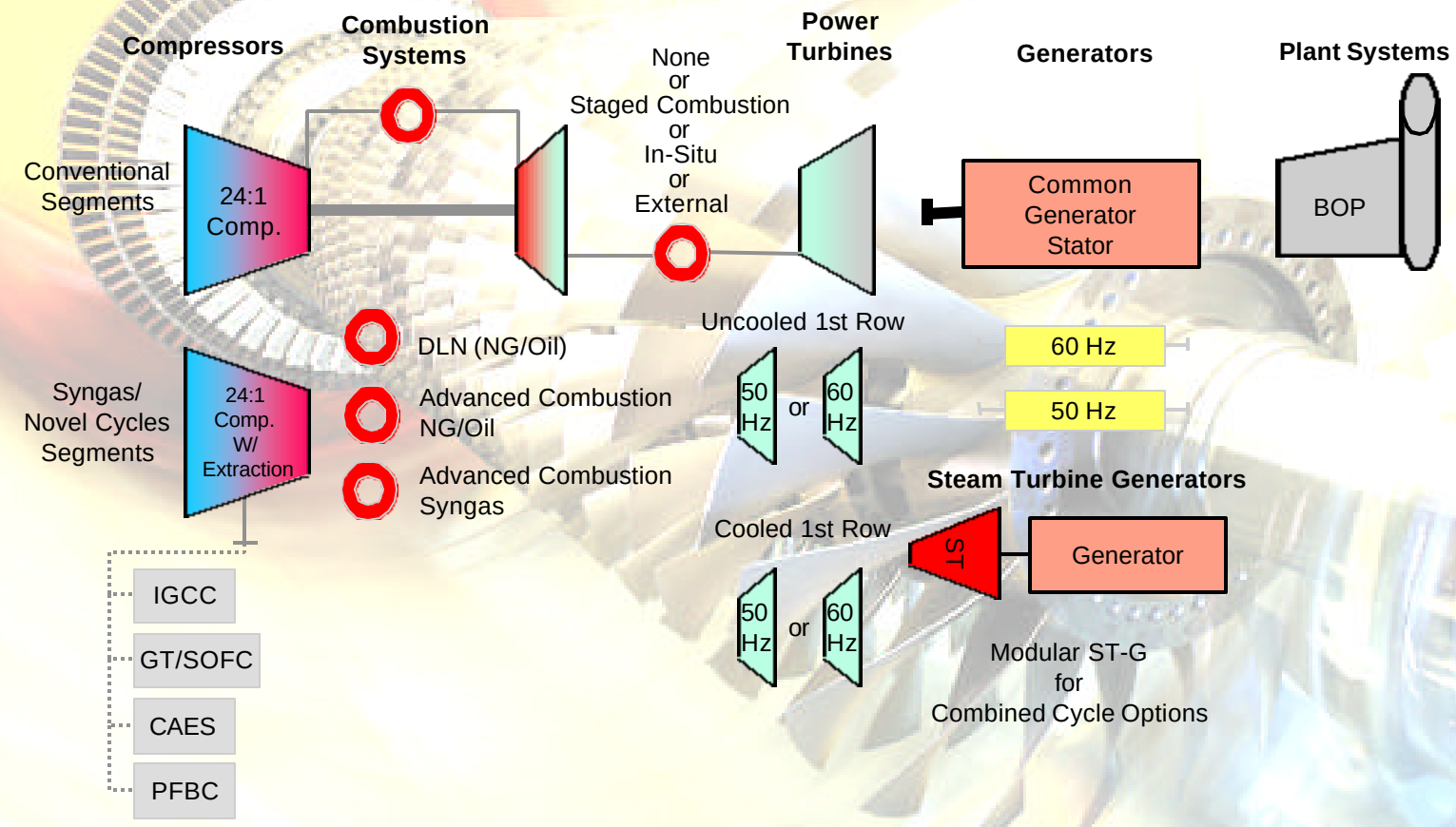
Next Generation Gas Turbine Systems

Technical Approach



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Next Generation Gas Turbine Systems

Study Major Results

GT Class	Performance	Costs
130 MW Two Shaft	>15% eff. SC	vs. F-Class: Cost Increase.
130 MW Single Shaft	>15% eff. SC	vs. F-Class: Same Cost
270 MW Peaker (Note 1)	>14% eff. SC	vs. F-Class: >15% Cost Reduction vs. G-Class: >20% Cost Reduction
300 MW (NG)	>15% power SC >15% power CC	vs. G-Class: Cost Increase vs. G-Class: Cost Increase
350 MW (syngas)	>15% power SC >14% power CC	vs. G-Class: Cost Increase vs. G-Class: Cost Increase

Note 1. Optimization for SC efficiency results in decreased power, increased costs, and makes GT less compatible with the bottoming cycle.

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Next Generation Gas Turbine Systems

Conclusions

- Technology Focus not Specific System Size
  - Development Costs
  - Uncertain Market
  - Better Investment: Efficiency, Power, Reliability
- Performance and Cost Goals Achieved for Specific Applications
- Larger GTs with Greater Reliability Preferred

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GAS TURBINE REHEAT USING INSITU COMBUSTION (DE-FC26-OONT40913)

Siemens Westinghouse Power Corporation
for
U.S. Department of Energy
National Energy Technology Laboratory

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Gas Turbine Reheat Using Insitu Combustion

Scope of Work

- 2 yr. Program
- Establish Proof-of-Principal
  - Blade Path Aerodynamics
  - Combustion & Emissions
  - Subscale Testing
  - Conceptual Design

Objective

- Evaluate Insitu Combustion Process as a Means for
  - Cycle Reheat
  - Power Augmentation
  - Minimizing Blade Cooling Losses
  - Low NO_x Approach

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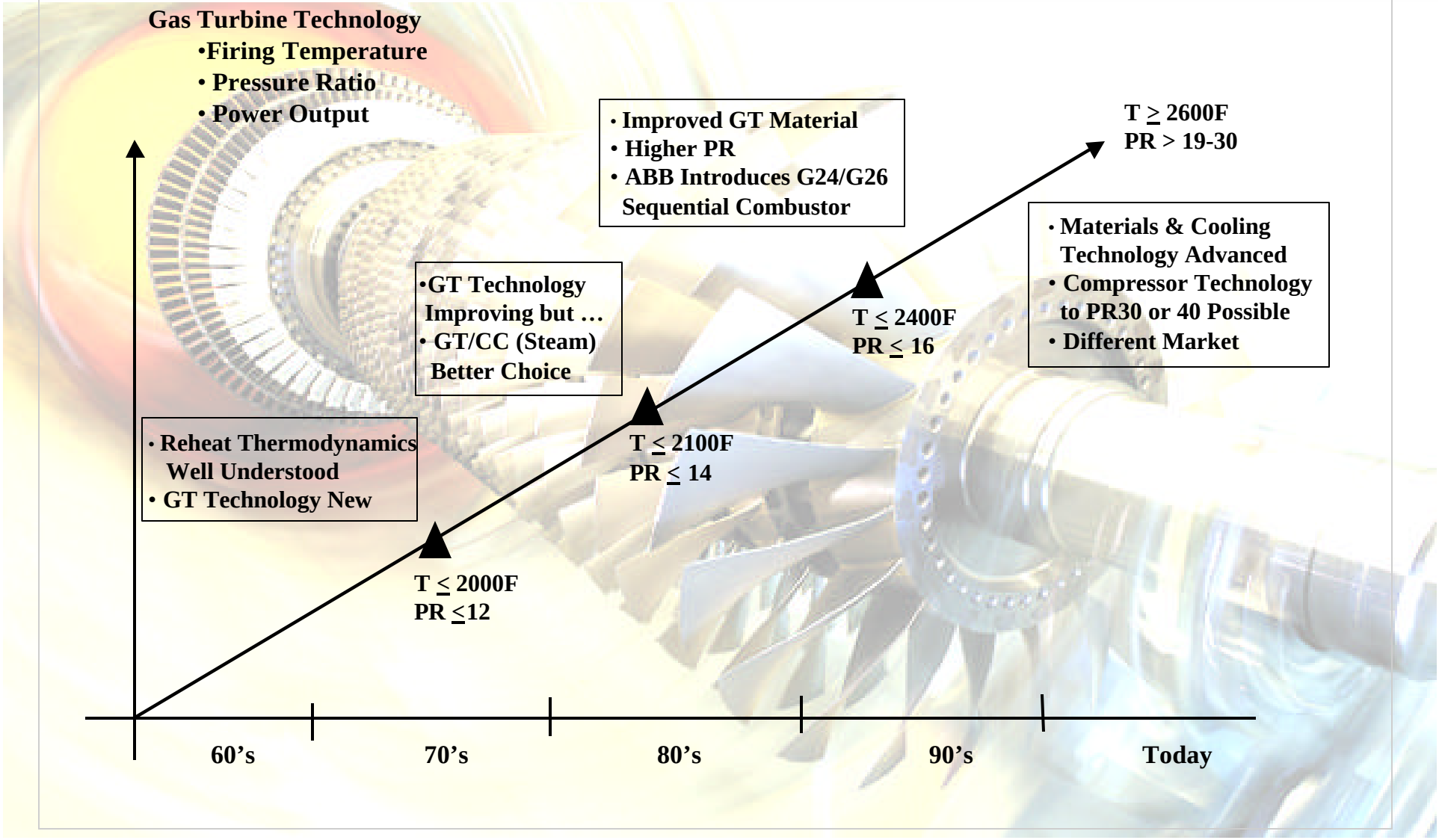
REHEAT - WHAT HAS CHANGED



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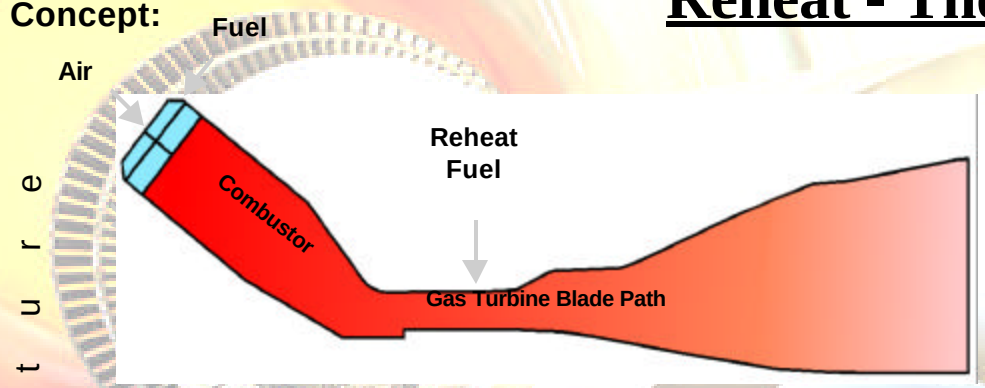
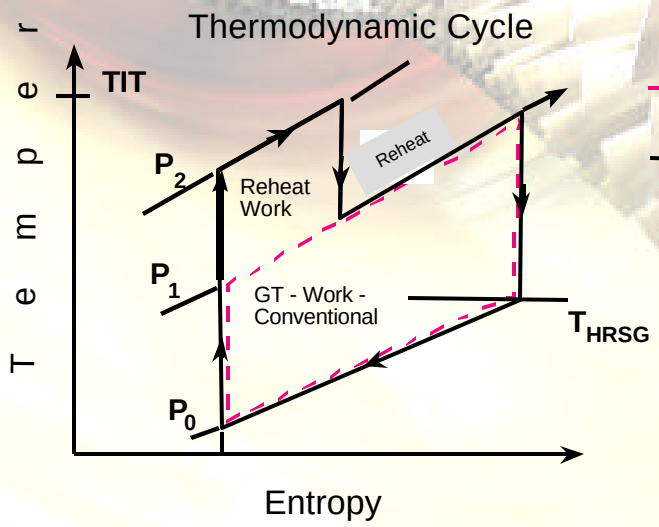
Gas Turbine Reheat Using Insitu Combustion

Reheat - Thermodynamic Cycle

Concept:





Conventional GT - Brayton Cycle

Reheat GT - Brayton Cycle

Power Cycle Applications

- Inject fuel into hot blade path
  - 1st Stage
  - 2nd Stage
- Ignite and burn fuel
- Accomplish gas temperature increase

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Gas Turbine Reheat Using Insitu Combustion

Benefits

Applications	Market	
	Retrofit	New Engines
♦ "Reheat" for Efficiency and Power Gain		X
♦ "Reheat" for Power Augmentation	X	X
♦ "Reheat" as Approach for Minimizing Blade Cooling Losses	X	X
♦ "Reheat" as Low NO_x Approach	X	X

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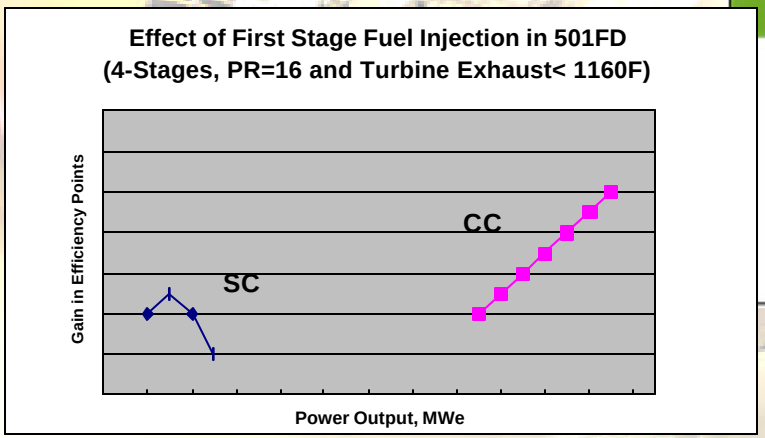
Gas Turbine Reheat Using Insitu Combustion

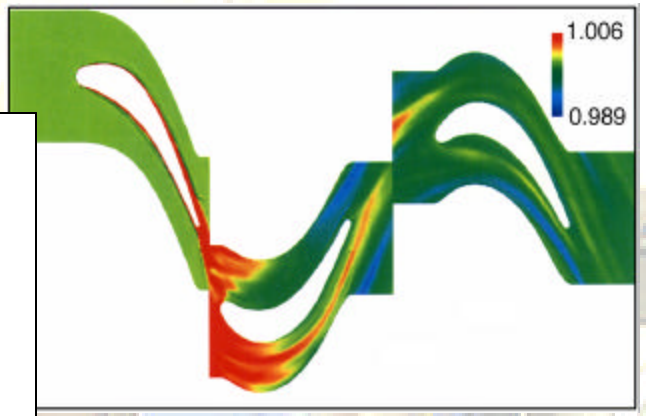
Technical Approach

Cycle Analysis



1. **Define Engine/Cycle Advantages**
   - **Simple Cycle (SC)**
   - **Combined Cycle (CC)**

Blade Path Aerodynamics



2. **Develop Analytical and Modeling Tools**
   - **Quasi 3D**
   - **Limited Combustion Kinetics**

Subscale Testing

3. **Proof-of-Concept Testing**

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ON-LINE TBC MONITORING FOR REAL TIME FAILURE PROTECTION AND LIFE MAXIMIZATION (DE-FC26-01NT41232)

Siemens Westinghouse Power Corporation
for
U.S. Department of Energy
National Energy Technology Laboratory

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On-Line TBC Monitoring For Real Time Failure Protection and Life Maximization

Scope of Work

- 4 Year Program
- System Definition and Design
- IR Characterization and Development
- Sensor Development
- TBC Life Model
- Supervisory System Development
- Field Testing

Objective

- Design and Test TBC Monitoring System for GT Blades and Vanes
- Monitor in Real-Time
- Analyze Radiance Map for Formation and Progression of TBC Defects
- Develop Lifing Model

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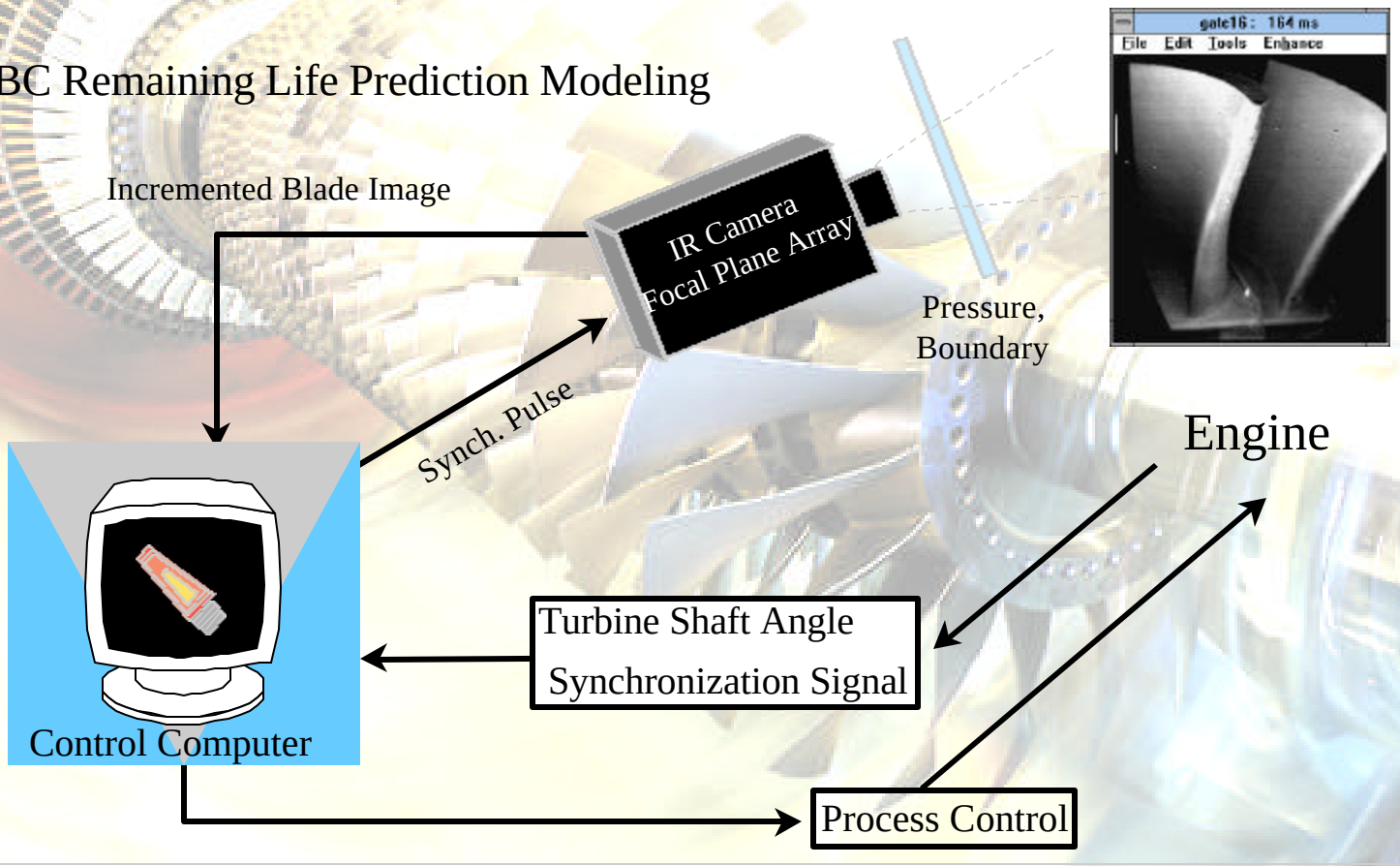
On-Line TBC Monitoring For Real Time Failure Protection and Life Maximization

Technical Approach

- Develop & implement advance monitoring sensors for row 1 vanes
- TBC Remaining Life Prediction Modeling



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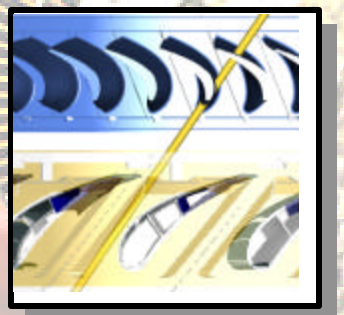
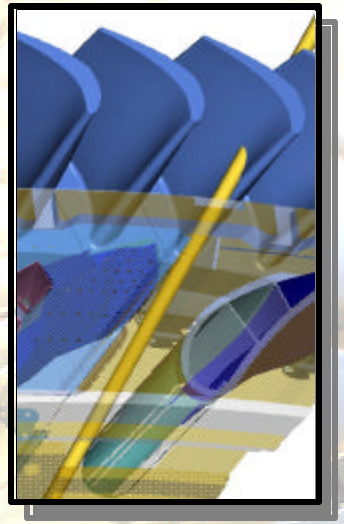
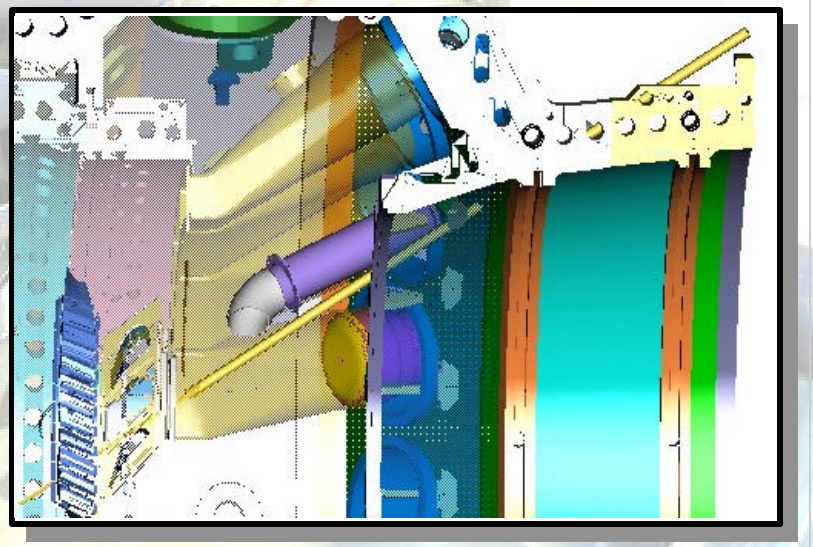
On-Line TBC Monitoring For Real Time Failure Protection and Life Maximization

Technical Approach

- Define Processes with 3D Models







- Next Generation infrared sensors

- Define a radiance map of row 1 blades

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On-Line TBC Monitoring For Real Time Failure Protection and Life Maximization

Benefits

- Significantly improve plant reliability and availability by extending life of critical components
- Maximize safe operating life of critical components
- Reduce the risk of unscheduled outages
- Applicable to most styles of Gas Turbines
- Encourages US high tech jobs and employment